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Alberta

MUNICIPAL AFFAIRS

Innovative Housing Grants Program

92-04377/

DEVELOPMENT, TESTING, AND PRODUCT LISTING OF TWO NEW FIRE-RETARDANT PRODUCTS FOR NEW HOME CONSTRUCTION

DECEMBER 1990

Prepared by:

M. J. Mabey
Marathon Coatings Technology Ltd.

with technical writing assistance
from

Greg Hickmore

The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of Alberta Municipal Affairs.

With funding provided by
Alberta Municipal Affairs

ISBN: 0-88654-310-X

FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of Alberta Municipal Affairs. The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

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As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

Innovative Housing Grants Program
Alberta Municipal Affairs
Housing Division
Research and Development Section
16th Floor, CityCentre
10155 - 102 Street
Edmonton, Alberta
T5J 4L4

Telephone: (403) 427-8150

TABLE OF CONTENTS

EXECUTIVE SUMMARY	ii
1.0 INTRODUCTION	1
1.1. Description of the Fire-Retardant Coatings	3
1.2. Project Objectives	3
1.3. Scope	5
1.4. Research Methods and Sources	6
1.5. Structure of the Report	9
2.0 ALBERTA BUILDING CODE REQUIREMENTS	11
2.1 Improvement of Flame-Spread Rating	13
3.0 PRODUCT CERTIFICATION	15
3.1. Test Method	15
4.0 PRODUCT DEVELOPMENT	18
4.1. Development of Safecoat 451	18
4.2. Development of Marathon 1303	21
5.0 CERTIFICATION	25
5.1. Certification Testing of Safecoat 451	25
5.2. Alberta Approval of Safecoat 451	27
6.0 MARKET OPPORTUNITIES	29
6.1. Prefinished Mill Products	29
6.2. Residential Applications	34
7.0 MARKETING METHODS	38
8.0 CONCLUSIONS	40
Appendix A: Weyerhaeuser Report	A1 - A9
Appendix B: Warnock Hersey Report	B1 - B31
Appendix C: Alberta Labour Standata	C1 - C5

EXECUTIVE SUMMARY

Introduction

This project comprised the development (as applicable), testing and certification of two fire-retardant coatings--Safecoat 451 and Marathon 1303--for use in wood-based residential construction. Potential economic benefits and market opportunities were also explored during the project.

Development of Safecoat 451 was essentially complete at the onset of the project, while Marathon 1303 was still in the development stage. The work therefore focussed on the completion of development of Marathon 1303 and the testing of both products.

Methods

Completion of development of Marathon 1303 was carried out in-house at the laboratory of Marathon Coatings Technology Ltd., through an optimization process involving trial and substitution of various synthetic resins. Since both products are proprietary, details of their composition have not been included in the project document. In generic terms, Safecoat 451 is a PVC resin-based intumescent coating material, which swells to many times its applied thickness to form a

fire-resistant barrier when exposed to high heat and flame. Marathon 1303 is a water-based halogen-donor coating which, when exposed to flames, emits halogen gas which, in turn, contributes to extinguishing the flame.

The study focussed on plywood and oriented strand board (OSB) as substrates for the coatings. Prior to actual certification, both products underwent preliminary testing at various private, but unaccredited, laboratories. The purposes of this preliminary testing were to establish optimum coverage rates and to assess the adequacy of the coatings from a flame-spread rating perspective. (Flame-spread is the value used in the Building Code to determine allowable uses for various materials, depending on their flammability. The lower the flame-spread rating, the better.)

Subsequent certification testing, carried out in accordance with CAN4-S102-M83 "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies," was performed by Warnock Hersey Professional Services Ltd. in Vancouver, B.C. In addition to plywood and OSB, fir dimension lumber was used as a substrate for testing.

Product pricing and investigation of potential market

opportunities were carried out coincident with development and testing work.

Results

Safecoat 451 showed excellent flame-spread results during preliminary testing, with single-coat coverage rates of 4.1 m^2/l (200 ft^2/gal) for plywood and 3.7 m^2/l (180 ft^2/gal) for OSB. Marathon 1303 did not provide anticipated flame-spread ratings to the substrates because its water base causes "stippling" at the surface of the substrates, which effectively increased their surface area and thus made them more prone to flammability, rather than less, as was intended. The decision was made, therefore, to proceed to certification testing with Safecoat 451 only.

Certification testing of Safecoat 451 yielded excellent results. At the predetermined coverage rates, flame-spread ratings of 11, 24, and 20 were achieved on fir dimension lumber, OSB, and plywood substrates respectively. Flame-spread ratings of less than or equal to 25 are assigned a Class A rating.

General residential construction and factory pre-application to panelboard products were identified as two major residential-based markets for Safecoat 451.

Costs of $\$0.23/ft^2$ for factory finishing and $\$0.29$ to $\$0.33/ft^2$ (depending on substrate material) for on-site application, coupled with the need for only a single coat to achieve a Class A rating, compare very favourably with competitive products.

Conclusions

Submission of certification testing results to Alberta Labour, Building Standards Branch, resulted in the issuance of a Standata document, approving the use of Safecoat 451 for various substrates and code applications requiring a Class A flame-spread rating.

Certification and approval-for-use of Safecoat 451 have resulted in the availability of an efficient and cost-effective fire-retardant product which will benefit the residential construction industry and expand the range of application of wood and wood products in the realm of fire-rated construction.

1.0. INTRODUCTION

The use of almost all wood-based construction materials is limited to the capacity of those materials to resist fire. Property losses owing to fire in Canada are among the highest in the world. In fact, an article in the Ottawa Citizen (December 3, 1989) stated that, on a world scale, Canada's fire losses are the third highest, exceeded only by Hungary and the USA. These costs do not factor in the loss of life.

Therefore, regulatory agencies, the insurance industry, and the public have a growing concern with the increased incidence and severity of loss due to fire. Such concerns have resulted in many revisions to both the national and provincial Fire and Building Codes. Many of these revisions have concentrated on upgrading the minimum acceptable standards of flammability for building materials.

This ongoing revision process affects the uses and limitations of many wood-based building products. For builders and the housing market, these changes and limitations present real challenges, both technically and economically. One answer to these challenges is the development of effective fire-retardant coatings.

Certain chemical additives, when applied to wood, significantly improve fire-resistance properties and thus expand the extent to which that wood may be used in construction work. These additives are known as "fire-retardants."

This project encompassed the development and certification of two such fire-retardant coatings: Safecoat Formula 451 and Marathon 1303.

In the initial data-gathering phase, discussions with officials of the Edmonton Fire Marshall's Office, the General Safety Services Division of the Building Standards Branch of Alberta Labour, Alberta Mortgage and Housing, various architects, and a mechanical engineer indicated that there is a broad range of potential applications for flame-spread rated surface coating products. Among the applications cited were both flame-spread abatement and improvements to fire-resistance ratings (endurance) for membranes and systems from stress skin panels to wood joists and I-beams.

1.1. DESCRIPTION OF THE FIRE-RETARDANT COATINGS

1.1.1. Safecoat 451

Safecoat 451 is an intumescent, fire-retardant, latex-based coating. When exposed to fire, the coating swells to many times its applied dry-film thickness; in doing so, it forms a non-flammable protective coating over the material to which it has been applied. Because product development work for Safecoat 451 had been completed, certification of the product was covered during this project.

1.1.2. Marathon 1303

Marathon 1303 features a highly water-resistant resin. When exposed to fire, the coating produces halogen gas that serves to extinguish the flame. In addition to incorporating fire-retardant chemicals, the coating is compatible with a termite repellant. Product development work on Marathon 1303 was completed during this project.

1.2. PROJECT OBJECTIVES

This project involved the testing and certification of Safecoat 451 and the development and testing of Marathon 1303 for use in wood-based construction in

Alberta. In addition, the project addressed the utility of these fire-retardant coatings within the residential segment of the construction industry. In particular, the technical and economic benefits of both site applications and factory pre-finishing of sheathing products were examined.

Applications of both coatings to plywood and oriented strand board (OSB) were studied and tested because each of these is commonly used as sheeting/sheathing material in the Alberta house-building market.

The principal objectives of this study fell into two major categories. First was the development, testing, and certification of the products. The second was the investigation of marketing opportunities in the Alberta home-building industry. Specifically, the objectives were as follows:

1. to research and determine the requirements for Canadian certification of both coatings and subsequently to develop a testing plan for those requirements; to complete the development of Marathon 1303; to perform the necessary testing of Safecoat 451 and Marathon 1303; and to obtain Canadian certification and listings for both Safecoat 451 and Marathon 1303;

2. to carry out an economic evaluation and analysis for the feasibility and marketing opportunities for both Safecoat Formula 451 and Marathon 1303.

1.3. SCOPE

In the initial planning and analysis phase, contact was established with major producing mills in Alberta that manufacture and supply plywood and oriented strand board sheet materials to the residential construction industry.

In addition to establishing these sources of information and assistance, a search of existing literature on the subject of fire-retardant coatings was carried out.

The requirements necessary for obtaining product certification for the two coatings in Canada were also determined. A two-stage testing plan was developed for the two products in their intended-use format to meet the requirements of the certification agencies. First, in-house testing was performed to provide measurable degrees of confidence that the coatings would meet or exceed the requirements of the certification agencies.

Such things as performance measurement, improvement techniques, water-resistance ability, fire-retardancy, cost, and practicality were examined. Certification testing was subsequently performed by an accredited laboratory; the results of this testing were then submitted to relevant building code authorities for their examination.

Finally, technical and economic analyses were carried out to gather data in three major areas of concern: feasibility, cost-benefit advantages, and marketing. The study examined those areas, investigating in particular the (1) feasibility and mechanics of incorporating Safecoat 451 and Marathon 1303 during the manufacture of plywood and OSB; (2) cost-benefit advantages of Safecoat 451 and Marathon 1303 compared to other fire-retardant products and processes currently available to the Alberta home-building industry; and (3) potential coatings markets and the most effective methods of reaching them.

1.4. RESEARCH METHODS AND SOURCES

1.4.1 Primary Sources

The Alberta Building Code

The starting point for research into fire-retardant

coatings used in the Alberta residential construction industry must naturally begin with the Alberta Building Code, which governs such construction. The Code specifies uses and limitations of wood-based construction materials (see Section 2 of this report) as well as testing methods required for certification for various conditions of use. But to achieve the objectives of this project, many other sources of information and data from testing were required.

Industry and Other Expert Sources

Much information in this report is derived from a wide variety of experts who deal with the Building Code, fire safety, and industry standards. Interviews, for example, were conducted with experts who deal with these issues daily--Fire Marshalls, architects, a mechanical engineer, and several Alberta Building Code officials. Similarly, when necessary, other experts were consulted; for example, technical staff at Alberta Research Council were consulted.

In addition, significant information was gathered from interviews with associations and special interest groups such as the Council of Forest Industries (COFI), the American Plywood Association (APA), the Waferboard Association, Forintek Canada Corp., The National Fire

Prevention Association (NFPA), among others.

Some of the most innovative ideas for factory finishing of building products came from problem-solving sessions with manufacturers, builders, architects, and product marketers. (See Section 6 of this report.)

Laboratory Testing

The primary technical data, dealing with product development, testing, and certification of the products, was derived from laboratory testing, both performed in-house and by accredited outside laboratories. (See Sections 3.1, 4.3, and 5.1 and 5.2 of this report.)

1.4.2. SECONDARY SOURCES

Literature Search

Additional information was gathered from secondary sources. A great deal has been written about the various technologies available to reduce the number and severity of losses due to fire. The Canadian and US Patent Offices also offer several areas for research into the subject of fire retardancy. Unfortunately, most of the publishing and patent activity in the areas

of fire retardancy and of emulsion technology ended in the late 1960s. This cessation of activity was coincidental with changes to the Canadian Patent Law. Since that time, any newly published data has come from the suppliers of the various raw materials.

Another source of current information on fire and fire-retardancy issues is The National Fire Prevention Association's monthly publications. Similarly, several other journals dedicated to design, engineering, and the fire-fighting profession provide information on the causes and effects of fire under various conditions.

Few of these publications or patent documents, however, actually cover the chemistry of combustion or the chemistry of protective coatings. The few available patents discussed the use of fire-retardant products in unique and functional building systems rather than covering the specific chemistry incorporated in the mixture.

1.5. STRUCTURE OF THE REPORT

This report is organized in the following manner:

Section 2 provides an overview of the flame-spread

requirements of the Alberta Building Code.

Section 3 then deals with the requirements for product certification, describing the testing methods in detail, while Section 4 describes product development of Marathon 1303 as well as preliminary testing of both Safecoat 451 and Marathon 1303 prior to certification procedures.

Section 5 goes on to discuss the certification of Safecoat 451.

Section 6 outlines a number of market opportunities for the coatings, focussing on use in manufacturing and in residential construction, and Section 7 gives an overview of the some of the typical ways the products could be effectively marketed.

Section 8 provides the conclusions of the study.

2.0. ALBERTA BUILDING CODE REQUIREMENTS

The Alberta Building Code and the National Building Code as well as the National Fire Code classify buildings (or parts of buildings) by "Major Occupancy." Alberta Labour, Building Standards, explains in general terms that for both combustible and non-combustible construction, "required flame-spread ratings depend upon specific location in a room, space or building and upon the use and occupancy of the space. . . ."

Substrates covered by the Building Code include (a) interior surfaces of habitable spaces; (b) concealed surfaces and cavities as an alternative to the mandatory use of sprinklers; (c) return-air plenum applications for air-handling systems.

Depending on the location of the surface and the type of occupancy, flame-spread requirements are generally divided into three classifications. Classifications are developed by comparing the flame-spread rating of materials to bare red oak (which is arbitrarily assigned a rating of 100 because of its flammability) and to asbestos cement (which is given a rating of 0). The classifications affecting residential construction are as follows:

Class A, the strictest rating, has a flame-spread rating of 25 or less; Class B has a rating of between 26 and 75; and Class C has a rating between 76 and 200.

The Alberta Building Code, in Parts 3, 6, and 9, specifies the minimum standards for surface burning characteristics by dictating the minimum flame-spread ratings for surfaces of each type of "Major Occupancy."

Combustible Construction

Part 3 of the Building Code specifies that in multiple occupancy situations, "when a building is permitted to be of combustible construction" (3.1.4.1.[1]) the materials must "have a flame-spread rating of not more than 25" (3.1.4.2.[1]). Subsection 3.1.10. specifies the "Flame-Spread Rating and Smoke Developed Classification." Subsection 3.1.11., covers "Interior Finishes," and specifies flame-spread requirements for building construction materials, with some ratings being not more than 200 and some not being more than 150.

Part 9, which covers "Housing and Small Buildings," specifies flame-spread ratings "shall be determined in accordance with . . . . Part 3" (9.10.3.2.). Subsection 9.10.16. specifies "Flame-Spread Limits," with typical flame-spread ratings being not more

than 150 for "the exposed surface of every interior wall and ceiling" and not more than 200 for "doors." However, in "exits," for example, walls and ceilings must have a flame-spread rating of "not more than 25."

Non-combustible Construction

For non-combustible construction, the use of combustible finishes is regulated by Clauses 3.1.4.5. (3) (f), (g), and (h).

2.1. Improvement of Flame-Spread Rating

Many authorities concerned with safety in apartment buildings, schools, and institutions require a Class A rating on materials used in those types of buildings. The Class A rating means the material must have a flame-spread test rating of 25 or less. Similarly, the Alberta Building Code specifies Class A for many portions of residential structures. (See the Alberta Building Code requirements discussion in Section 2 of this report.)

Architects, engineers, designers, and building inspectors therefore look for effective and economical methods to lower the inherent flammability of the construction materials. One method is the use of

fire-retardant coatings. For example, plywood, if bare or if painted with normal paint or varnished, has a flame-spread rating of 150 (Class C). That flame-spread rating can be improved significantly when the same material is coated with a fire-retardant; such a coating could lower the flame-spread rating to less than 25, giving the material a Class A rating.

3.0. PRODUCT CERTIFICATION

The National Building Code, the basis for all provincial Codes, calls for particular products intended for use in specific areas of risk to be tested to a specified classification under a defined test method.

Architects, building inspectors, and builders put their trust in the "listing and labelling service" of accredited laboratories. Each product is tested and rated to a standard flame-spread classification, (Class A, B, C, D, or E), on a specified substrate. If the product or assembly is labelled appropriately, designers can specify its use. No other consideration is needed from the point of view of the Building Code.

3.1. Test Method

The effectiveness of a fire-retardant coating, treatment, or paint is judged by a "burn test." The test that has become most widely accepted by Code authorities is the "Steiner Tunnel Test," specified in CAN4-S102-M83, "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies."

(Other similar and well-known tests are the ASTM E84-61, the NFPA No. 255, and the UBC 42-1.)

The Steiner Tunnel Test evaluates the fire-retardant effectiveness of materials by measuring the rate of "flame-spread," the fuel contributed, and the amount of smoke developed under actual fire conditions. The amount of smoke produced has been recognized as an important factor in fires because of loss of life owing to asphyxiation.

The Steiner Tunnel is a large, horizontal test chamber with a removable roof. The material specimen to be tested is of approximately the same dimension as the tunnel interior (54.6 cm by 7.6 m [21.5 in. by 25 ft.]) and is placed at roof level within the chamber. A gas flame, burning under controlled conditions, is directed against the underside of the specimen. Flame-spread, fuel contributed, and smoke developed are then measured by various instrumentation devices integral to the tunnel structure.

Rate of Flame-Spread. The rate of flame-spread is determined through comparison with unpainted Grade A red oak, which is completely combustible and is arbitrarily assigned a flame-spread rating of 100. The other point of comparison is unpainted asbestos-cement,

which is non-flammable and is assigned a rating of 0.

Fuel Contributed. Fuel contributed (or heat generated) by the test specimen is measured by the temperature at the tunnel vent. It is assumed that the higher the temperature, the more fuel the test specimen is contributing. Again, unpainted red oak is rated 100, and asbestos-cement is rated 0.

Smoke Developed. Smoke density is the degree to which the test chamber is obscured by smoke. The degree of obscurity is measured by the intensity of light from a source directed at a photo-electric sensor at the exhaust end of the tunnel. As before, unpainted red oak is rated 100, and asbestos-cement is rated 0.

4.0. PRODUCT DEVELOPMENT

As part of the product development process, both Marathon 1303 as well as Safecoat 451 also underwent extensive testing at other laboratories, including Forintek Canada Corp., Weyerhaeuser Company USA, and the Alberta Research Council.

Several potential end-user building-products companies co-operated in offering technical support in the early stages of developing and screeening the products.

These early tests at in-house and outside laboratories were extremely valuable in determining which products (or variations of products) should be tested and at which coverage rates they should be tested.

4.1. Development of Safecoat 451

Development of Safecoat 451 was virtually complete by the inception of this project.

4.1.1 Component Specification of Safecoat 451

In generic terms, Safecoat 451 is a high-solids coating formula based on a PVC resin in combination with amides, phosphates, and hydroxy-functional additives

in sufficient proportions to produce effective fire-retardant properties. The coating is also highly resistant to atmospheric moisture.

The coating reacts to the heat of fire to form a thick, insulating layer of non-combustible char. That layer reduces flame-spread by insulating against heat and cutting off oxygen to the flammable surface.

The exact "component specification" for Safecoat 451, however, is a proprietary formula and cannot be presented here.

4.1.2. Preliminary Testing of Safecoat 451

Because development of Safecoat 451 was already completed by the inception of this project, testing of the product was the main focus during these early stages of the project:

1. Tests conducted at the Weyerhaeuser fire-door plant in Wisconsin showed that Safecoat has excellent promise as a method for improving fire-endurance ratings for fire separation walls and ceilings of several substrates (from Type X gypsum to plywood sheeting).

2. Safecoat was tested on fire-retardant treated (FRT)

plywood by the Weyerhaeuser plywood facility in Longview, Washington, using a severe 30-minute fire test (ASTM E84/30). (The CAN4-S102-M83 test, by comparison, is for 10 minutes.) The 30-minute test results showed that, given the right coverage, SAFECOAT would prove adequate. According to the test report, the coating could not be considered "FRT" (fire-retardant treated) material because the flame-front exceeded the test's specified 10.5 foot mark); however, the maximum flame travel was only "14 feet, which suggests that perhaps a slightly heavier coating would enable the combination to be considered FRT." (See Appendix A.)

3. A major fibreboard producer tested both Safecoat and Marathon 1303 for use in several different sheathing applications.

Preliminary results from testing work carried out in Edmonton and at the Weyerhaeuser Fire Testing Facility in Longview, Washington, gave sufficient data to determine optimum coverage rates for the Safecoat 451 to achieve a Class A rating. The single-coat coverage was established at:

4.1 m^2/l (200 ft^2/gal) for Douglas fir decking and for SPF plywood, and

3.7 m^2/l (180 ft^2/gal) for OSB.

The preliminary review lead to a recommendation that formal laboratory testing of Safecoat 451 should proceed, with confidence that a Class A Flame-Spread Rating under CAN4-S102-M83 would result.

4.2. Development of Marathon 1303

Marathon 1303 was developed during the term of the project.

4.2.1. Component Specification of Marathon 1303

In generic terms, Marathon 1303 is a water-based coating system containing latex synthetic neoprene resin in combination with bromides and reagent additives in sufficient proportions to produce a coating that resists fire and exhibits excellent water resistance.

When exposed to the heat of fire, Marathon 1303 reacts by decomposing and giving off halogen gas which is known to interrupt the chemistry of combustion. The coating thus reduces flame-spread on the flammable surface.

Marathon 1303 may be enhanced with a mixture of TCMTB,

a highly effective mold, mildew, and termite inhibitor.

The exact formula of Marathon 1303 is a proprietary formula, however, and its details cannot be given here.

4.2.2. Preliminary Testing of Marathon 1303

In-house testing and experimentation were used to develop various formulations of 1303 (or variations of the initial 1303 formula) in order to arrive at the most cost-effective mix of materials to produce desired ratings.

Numerous small-scale tests using an ASTM D113 small-scale burner were run to test various mixtures of the active ingredients of 1303 to optimize results on a variety of substrates such as fibreboard, OSB, and plywood. Comparative results were measured. However, the small-scale ASTM alcohol burner limited the size and intensity of the heat source during screening tests, and the small-scale test (lasting just over four minutes) proved unreliable compared to the Steiner Tunnel test.

In 1989, Forintek Canada Corp. of Montreal included Marathon 1303 in a review of surface coatings for use

on waferboard. In addition, a major fibreboard producer also tested it for use in a variety of sheathing applications. The flame-spread index for the fibreboard was improved.

However, large-scale testing indicated that OSB was adversely affected by the addition of this water-based coating. When consulted about this, technical staff at Alberta Research Council, Edmonton, identified three probable reasons for the poor performance of OSB coated with 1303:

1. OSB has a tendency to delaminate when subjected to moisture, and this causes a "stippling effect," which increases the relative surface area (1303 is a water-based coating). The stippling effect does not take place with the intumescent product (Safecoat 451) because that coating swells up to fill voids and to cover surface inconsistencies.

2. All previous screening tests were carried out on fibreboard that has a density of approximately 243 kg/m^3 (15 lbs/ft^3). Fibreboard offers less available fuel per cubic foot than OSB, which has a density of 648 kg/m^3 (40 lbs/ft^3).

3. Unlike OSB, fibreboard lacks waxes, phenols,

and isocyanurate resins that contribute to flammability.

Given this adverse effect, the decision was made to discontinue certification efforts for Marathon 1303.

5.0 CERTIFICATION

Once a fire-retardant product has been tested, approved, and labelled, it can be used in any application within the appropriate Flame-Spread Rating limits specified in the Building Code for the particular use intended, on the approved substrate.

5.1 Certification Testing of Safecoat 451

The Building Code specifies that "flame-spread rating and smoke developed classification of a material, assembly of materials or structural member shall be determined on the basis of at least 3 tests conducted in conformance with CAN4-S102-M83, "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies" (3.1.10.[1]).

Because the company-owned laboratories where preliminary testing was done (see Section 4) were not viewed as "independent" testing authorities by the regulatory agencies, the preliminary test results could not be used for certification purposes.

Therefore, Warnock Hersey Professional Services Ltd., an independent and accredited laboratory, was contracted to perform the requisite CAN4-S102-M83

Flame-Spread test for Safecoat 451. In order to offer the widest scope of application in the building contractor marketplace, the testing was to be done on Douglas fir decking, SPF plywood, and OSB.

In mid-December 1989, under the supervision of a Warnock Hersey engineer, a batch of Safecoat 451 was manufactured, and the batch was transported to the Warnock Hersey laboratories. Warnock Hersey technicians subsequently ran three Steiner Tunnel tests for each substrate using a single coat of Safecoat 451.

The flame-spread rating results were as follows:

Douglas fir decking (25 mm): flame-spread of 11
OSB (25 mm): flame-spread of 24
SPF plywood (25 mm): flame-spread of 20

All three substrates qualified as Class A ratings.

Results of the tests were compiled in a formal report (see Appendix B).

Warnock Hersey will list Safecoat in the current Certification Listings catalogue. The product is labelled and listed in the catalogue for general

distribution and use by regulating authorities. Periodic inspections of production are made by Warnock Hersey to ensure quality and consistency and to maintain the certification and listing status.

5.2. Alberta Approval of Safecoat 451

The Building Standards Branch of Alberta Labour is responsible for administering and enforcing the Alberta Building Code. As part of its duties, this agency reviews new product information to determine the acceptability for use on the basis of compliance with applicable Code requirements. Products that have not undergone necessary testing by accredited agencies cannot be reviewed in this context by the Building Standards Branch.

In March of 1990, the Warnock Hersey test results were submitted to Alberta Labour for review.

Pursuant to that review, Safecoat Formula 451 was approved for use as a Class A flame-retardant coating on the tested substrates. (See Appendix C, Alberta Labour Standata).

The General Safety Services Division of Alberta Labour also noted that Safecoat 451 could be used with other

types of wood, providing the lumber was at least 25 mm thick. The same ratings would apply to other woods such as "Eastern white pine, lodgepole pine, Pacific Coast yellow cedar, Select Red Oak flooring, Western hemlock, Western red cedar, Western white pine, and white spruce."

6.0. MARKET OPPORTUNITIES

There are two major marketing opportunities that would prove useful for Safecoat 451 fire-retardant coatings. The first is its use in prefinishing mill sheathing products such as plywood and OSB. The second involves various residential applications such as single-family dwellings and public housing projects.

6.1. Prefinished Mill Products

From the start of the project, discussions were ongoing with management at several Alberta-based panelboard mills. The panelboard industry has offered and continues to show considerable support for the possibility of incorporating some of the studied coatings into the manufacturing/finishing cycle. An important evaluation of several locally available coatings was carried out at the Alberta Research Council to determine whether such coatings were cost-effective and suitable for mill finishing.

Since that study, Safecoat 451 has been successful in three line-trials in the US. Weyerhaeuser has been able to spray-apply Safecoat using airless equipment at a rate of 22.5 m (75 ft)/ minute; Georgia Pacific has used a roller-coater at 24 m (80 ft)/ minute to cover

hardboard products; and Panel Processing Inc. of Michigan has used an open-weir curtain coater.

Economic analysis indicates that factory finishing of panelboard, plywood, and OSB would improve the saleability of these sheathing products in specialty markets, specifically roof sheathing markets in Canada and the US.

As an example of greater marketability, coated OSB offers a number of significant advantages. First, it is a substrate that is less expensive (up to 25% less) than plywood; coated OSB also has a lower overall cost per square foot, as much as 40% less than pressure-treated plywood. Pressure-treated plywood can also take up to ten weeks to ship to Alberta from British Columbia, so OSB has a much greater availability. Finally, coated OSB suffers no problems with corrosion to nails or truss plates, and there is no strength loss owing to material degradation (see Section 6.1.2, the discussion on acid hydrolysis).

6.1.1. Factory Finishing versus On-Site Application

Most approved and listed fire-retardant products require a two-coat application for coverage in the

range of 150 ft^2/gal. The price a builder pays (contractor pricing) is typically in the range of $55 to $75 per gallon. Safecoat 451, at $58.50 per gallon, requires single-coat application at the rate of 180 ft^2 /gal.

On-site application presumes that the contractor would purchase only enough fire-retardant necessary to accomplish the job at hand. Quantity price reductions would therefore not be available on a per-job basis. For Safecoat 451, on-site application would cost approximately $0.40/$ft^2$ ($58.50/gal ÷ 180 ft^2/gal + 20% labour).

Factory application implies that the producing mill would purchase and use the fire-retardant material in much greater quantity than would the contractor; therefore, quantity pricing would apply. For Safecoat 451, it is estimated that quantity pricing could be as low as $35/gal. The cost of factory application, then, would be in the order of $0.22/$ft^2$, including a factor of 15% for labour/handling costs. Factory and distributor mark-ups will vary in response to many market-related factors; however, the allocation of two mark-up levels--20% for the factory and 20% for the distributor--represents a reasonable method of

estimating the price a contractor/builder would pay for factory pre-finished material. Using those mark-up figures, the contractor price would be approximately $\$0.32/ft^2$, a savings of approximately 20% over on-site application costs.

6.1.2. Factory Finishing versus Fire-Retardant Treated Plywood

Fire-retardant treated (FRT) plywood sheathing is used in many North American code jurisdictions for multi-family units. (OSB is not available in a fire-retardant grade because it cannot be pressure-treated.)

Plywood's fire retardant, which is applied by a vacuum-pressure method, adds approximately $11 to $20 to the cost of a regular 15 mm sheet of plywood. Vacuum-pressure treated Douglas fir plywood is usually sold for about $42 per sheet ($\$14.10/m^2$ [$\$1.31/ft^2$]). This cost compares to the usual price of $21 for untreated plywood.

The cost of coating plywood at the mill compares favourably with the cost for pressure treating, yet it carries none of the liabilities associated with pressure treating. The actual cost of coating plywood

will be subject to economies of scale and local manufacturing versus importing.

The Problem of Acid Hydrolysis

The high cost of FRT plywood, however, is not the major drawback. Code authorities have identified a recurrent problem of "acid hydrolysis," which can sometimes require complete material replacement for correction.

Acid hydrolysis is the reaction that occurs when phosphate salts, the primary fire-retardant ingredient in the vacuum-pressure treating method, are subjected to high roof-deck temperatures and relatively high humidity. This combination causes the fire-retardant treatment to break down and form acids that cause the plywood to lose its structural properties.

Coating with Safecoat is an effective solution to this problem. Tests were run on CDX plywood (exterior grade sheathing, often used for roofing) treated with Safecoat. Not only is the problem of acid hydrolysis eliminated, but the coated plywood achieved a 30-minute Class A flame-spread rating. This qualifies for an "FRT" rating. Additional tests are being performed to gain International Council of Building Officials (ICBO) approval for this coating alternative to pressure-treating.

6.1.3. Technical Feasibility of Factory Finishing

Given the value-added benefits of coated panelboard in the new and retrofit housing industry, Alberta panelboard factories have expressed interest. One question that deserves consideration is the technical feasibility of factory pre-finishing. Factory finishing with approved coatings is technically feasible insofar as the technology for such finishing is already commonplace. It has existed in virtually all production facilities in the US for a number of years. Factory finishing of hardboard siding is also commonplace.

Factory finishing of various kinds is done routinely using roller coater systems or spray booths and drier lines. The equipment requirements would be the same for fire-retardant coating finishing.

6.2. Residential Applications

While the safety and economic benefits of fire-retardant coatings for all combustible wood-based building materials were cited by builders, architects, Code officials, and homeowners, there are a number of other specific applications that should be noted. These applications have promising marketing

possibilities and are discussed below.

6.2.1. Single-Family Dwellings

Use of fire-retardant finishes offers benefits to architects and builders in terms of "value-added" safety features in new and retrofit homes. But aside from the various technical and economic advantages builders would realize by using fire-retardant coatings on combustible construction materials in single-family dwellings, there are other less well-known uses and advantages to be had. For example, builders could make use of fire-retardant coated materials in the wall between a house and its attached garage.

The minimum flame-spread rating allowed by the Alberta Building Code for a garage sharing a wall with the house precludes using materials such as three-quarter-inch plywood or OSB which have not been treated for flame-spread control. The significance of this is that the material commonly used is gypsum board, and it does not provide security from illegal entry to the home through the garage.

Concerns have been raised over the risk of unlawful entry into private homes via their least secure access, that is, the attached garage. Police records show

cases where burglars have gained access to the garage and have "walked through" the gypsum-board wall into the living area. Authorities agree that gypsum board provides poor security, but untreated plywood or OSB are not acceptable because of their flame-spread ratings.

A solution to this is fire-retardant coated sheathing. In addition to providing improved security, fire-retardant coated sheathing could be used on a single wall and would offer not only better security but would also offer excellent price and performance when compared to the cost of on-site application of an approved fire-retardant coating to a plywood wall.

6.2.2. Public Housing Projects

Specifications in public housing projects may require a sheet of three-quarter-inch plywood under the gyproc sheeting in hallways, to resist damage by vandalism. Without question, this duplicate membrane system offers excellent resistance to vandalism while still providing a Class A flame-spread rating. However, this dual sheeting adds considerable expense to the cost of finishing the halls.

As an alternative to this, pre-finished sheathing of

plywood or OSB would be less expensive than the plywood-gypsum board system and would meet the Code requirements. As for the aesthetic considerations, builders could use good-one-side plywood and use vinyl trim for joints and finishing, similar to materials used with the vinyl overlaid panels available on the market today.

7.0 MARKETING METHODS

Because of the relative newness of the products, marketing would mainly focus on increasing industry and public awareness of Safecoat 451 and Marathon 1303 and their uses.

Potential users have been identified as falling into three main groups: manufacturers of plywood, OSB, and fibreboard; builders, architects, and others involved in home-building and retrofitting; and the "do-it-yourself" homeowner.

Manufacturers have been identified as being particularly interested in the cost advantages of the products, while builders and architects are interested in the safety aspect (as a "value-added" feature to homes) as well as the cost benefits. Homeowners, for the most part, are drawn by the safety and security features offered by the products.

For manufacturers and homebuilders, direct-mail information packages, outlining the products, their applications, and their cost-effectiveness are intended to be sent. Architects, homebuilders, and tradespeople can also be reached through various professional and trade publications. Press releases to, or small ads

in, such publications often have results far in excess of the space devoted to the products.

Because demonstrations of the product (for example, burn tests) have tremendous impact, they will constitute a major portion of the marketing effort.

Overall, the marketing strategies for these products will concentrate on presenting information about cost benefits, safety concerns, and versatility.

8.0. CONCLUSIONS

In general, the following conclusions can be drawn about Safecoat 451 and Marathon 1303:

1. Safecoat 451 was proven to be an effective fire-retardant coating, imparting a Class A flame-spread rating to the tested substrates, namely plywood and OSB. Marathon 1303 did not prove to be an effective fire-retardant coating on the tested substrates. It was found to work well on low-density fibreboard, but it is not cost-effective in this use compared to the currently used sheathing methods.

2. There is a market for fire-retardant coatings in the Alberta homebuilding industry, particularly for panelboard products, and Safecoat satisfies the needs of that market. Safecoat 451 is useful to builders in new and retrofit construction in terms of "value-added" benefits where homeowners place high priority on safety and security.

3. Safecoat has significant cost benefits over other types of coatings, both in initial price and in terms of its single-coat application.

4. Factory prefinishing of plywood and OSB with Safecoat is feasible. The resultant fire resistant products could address market segments previously accessible only to products such as FRT plywood and gypsum board.

APPENDIX A: Weyerhaeuser Report

INTRODUCTION

In this report, the results of the American Society for Testing and Materials (ASTM) Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM E 84-87a test are presented. This test is used to measure and comparatively describe the properties of materials, products, or assemblies in response to heat and surface flame conditions. These results are only applicable to the exact type of building material tested.

This test method is also described by ANSI 2.5, NFPA 255, UL 723, UBC 42-1, and UL 1256.

PURPOSE

The purpose of this test is to determine the burning characteristics of the material under test by evaluating the flame spread over its surface and the density of the smoke developed when exposed to a test fire. This will then develop a basis on which the surface burning characteristics of different materials may be compared.

In this ten minute test, a material is exposed to a calibrated flame which will produce a flame spread along the entire length of a red oak flooring calibration specimen in 5.5 minutes. By past methods of calculating Flame Spread Index (FSI) this meant that red oak flooring had an FSI of 100. However, the FSI equations were modified in 1979 resulting in red oak having an FSI of about 91. The Smoke Developed index value for red oak remains unchanged at 100. The FSI and Smoke Developed test results of a material are compared with those of red oak previously discussed and those of asbestos-cement board where FSI and Smoke Developed values are zero.

The FSI and Smoke Developed results are frequently used by building code officials and regulatory agencies for determining the acceptance of building materials used in various applications. The most widely accepted classification system for use of the tunnel results is found in the National Fire Protection Association Life Safety Code, NFPA 101 which indicates the following.:

Class A : 0 to 25 FSI
Class B: 26 to 75 FSI
Class C: 76 to 200 FSI
Class D: 201 to 500 FSI
Class E: Over 500 FSI

The accepted premise is that the higher the Flame Spread Index, the greater the fire hazard although the relationship between the numbers developed under this test and life safety in fire have not been adequately established.

SAMPLE PREPARATION

One set of samples consisting of two 21" x 96" x 7/16" pieces of Weyerhaeuser Structurwood were prepared for testing by applying Marathon Coatings. Sample # P2 at the rate of 75 ft^2/gallon. The samples were conditioned in the Weyerhaeuser Fire Technology FRT lab area for several days prior to testing.

TEST RESULTS

Material Description	Flame Spread Index	Smoke Developed Index
Structurwood with Marathon (75 ft^2/gal)	**10**	**45**
Red Oak Deck	91	100
Asbestos Cement Board	0	0

COMMENTS:

The test was conducted for 30 minutes to determine if the Structurwood with Marathon Coating could be considered "FRS" material (flame front not exceeding 10 1/2 feet). Somewhere between 18:30 and 20:05 into the test period the flame front crossed the 10 1/2' mark, disqualifying it as FRS. The maximum flame travel however, was 14 feet which suggests that perhaps a slightly heavier coating would enable the combination to be considered FRS.

Weyerhaeuser Company
Fire Technology Laboratory
Longview, Washington

E 84 TUNNEL DATA SHEET

SURFACE BURNING CHARACTERISTICS

Test No. 5 Sample No. _____ Specimen No. _____ Service Request # 8908-14

Sample Description Structurwood / Marathon 75 sq ft/gal Project Number 045-3534

Thickness 7/16" .455" Date 8/23/89 Time _____

Joints 8' Engineer JAW / NDP

Moisture Content _____ Percent _____ Lab Tech #1 _____ #2 BA

PreHeat Time 120 Seconds _____

Brick Temp. 110° °C _____

Draft Velocity 1.21 m/sec -Manometer "H_2O

Relative Humidity 54 %R.H.

Air Temperature 24 °C

Test Duration 1800 Seconds 30 min

	GWL	Conventional
Flame Spread rating:	10	..
Smoke Developed:	45 %T	;OD Value
Fuel Contributed:		

Final gas reading 986.60

Starting gas reading 940.37

Corrected gas flow _____

Gas Temperature _____ °C

Gas Pressure _____ "H_2O

Comments: 30 minute test

Max FS = 14 ft @ 27:05

Ignition time: Minutes _____ Seconds 220

12'6" 23:20 13'6" 25:01

Distance	Time	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Flame Front Advance	Sec.	28	209	479	13:00		18:30	20:05	22:30	23:50	27:05										
Flame Front Retreat	Sec.																				

0 4 8 12 16 20 24

22.75 lbs | 22.55 lbs | VOID

A-5

Test Method: ASTM E84-87a
DATA SHEET

Client:	Winchester Homes
Date:	13:29:49 08-23-1989
Test Number:	5
Project Number:	045-3539
Specimen ID:	

Structurwood w/ Marathon
SR# 8908-14

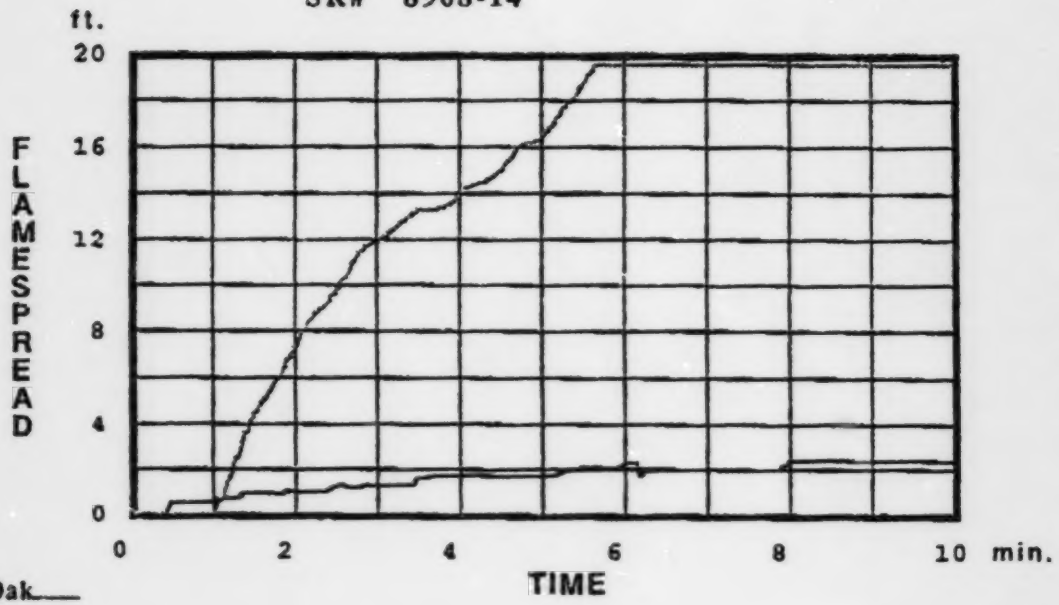
TEST RESULTS:

Flame Spread Index	=	10
Smoke Developed Index	=	45

SPECIMEN DATA . . .

Time to Ignition	=	3:40 (Min:Sec)
Time to Max FS	=	8:20 (Min:Sec)
Maximum FS	=	2.4 (Feet)
Time To 980 F	=	980 F Not Reached
FS • Time Area	=	16.9 (Ft • Min)
Smoke Area	=	36.9 (%T • Min)
Unrounded FSI	=	8.72
Unrounded SDI	=	45.09

Winchester Homes
5
Structurwood w/ Marathon
SR# 8908-14



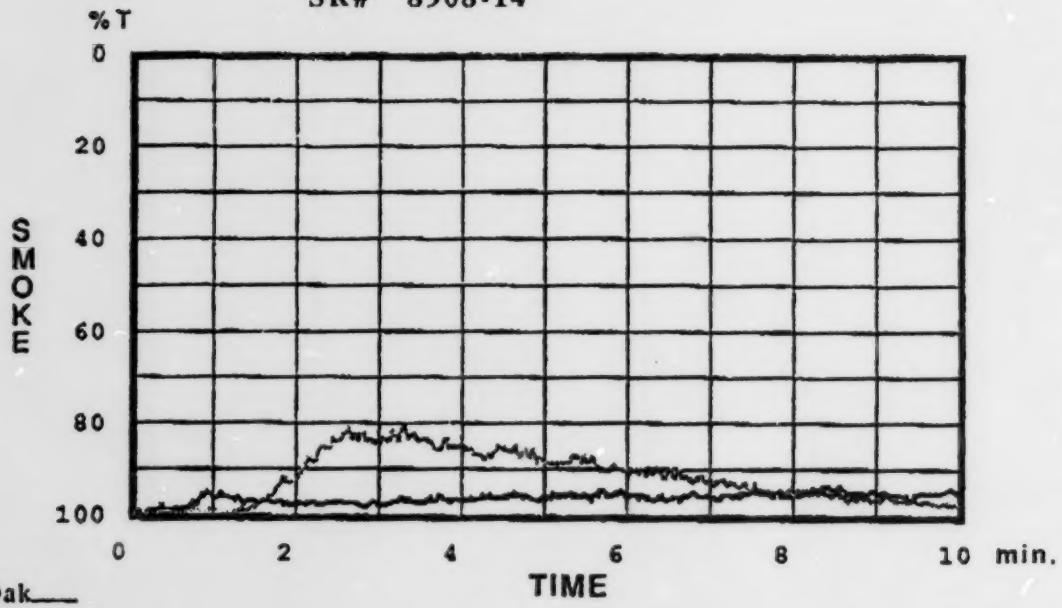
Red Oak

Winchester Homes

5

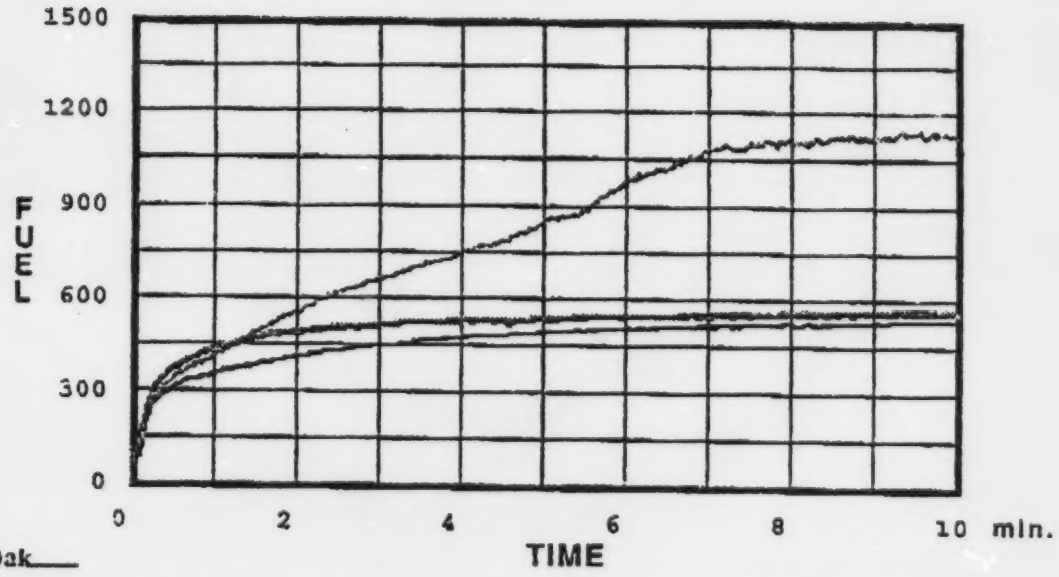
Structurwood w/ Marathon

SR# 8908-14



Red Oak___

Winchester Homes
5
Structurwood w/ Marathon
SR# 8908-14



Red Oak___
Reinforced Cement Board—

APPENDIX B: Warnock Hersey Report

Warnock Hersey

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.
211 SCHOOLHOUSE ST., COQUITLAM, BRITISH COLUMBIA
CANADA V3K 4X9 TELEPHONE (604) 520 3321
TELEX ENVOY WPM 8076 TELECOPIER (604) 524-9186

July 20, 1990

Marathon Coatings Technology Ltd.
P.O. Box 5914, Station L
Edmonton, Alberta
T6C 4G5

Attention: Mr. Mike Mabey

Dear Sir:

On March 21, 1990 at Warnock Hersey Professional Services Ltd., samples were prepared to determine wet and dry film thicknesses as requested by the client.

The substrate was 12" x 12" sheet metal, 0.025" thick and was cleaned with alcohol/solvent mixture. The Safecoat 451 was applied using an air type spray gun. The application rate was determined by a specific weight gain per metal sheet.

The weight required for each coverage was as follows:

1. 180 sq.ft./imp.gal. = 31.57 gm of Safecoat 451/sq.ft.
2. 200 sq.ft./imp.gal. = 28.41 gm of Safecoat 451/sq.ft.

COVERAGE/SQ.FT.	WEIGHT OF SAFECOAT 451	WEIGHT/OZ.	FILM THICKNESS
180	31.57 gm	20.48 gm	10.7 mil.(Wet)
200	28.41 gm	20.48 gm	9.63 mil.(Wet)
180	31.57 gm		6.125 mil.(Dry)
200	28.41 gm		5.5 mil.(Dry)

Note: The wet film thickness was determined by the weight of the applied material.

If there are any questions, please do not hesitate to call me.

Yours truly,

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.

Fred Yasuda
Senior Technician
Fire Laboratories Division

FY/mam

Warnock Hersey

WARNOCK HERSEY PROFESSIONAL SERVICES LTD
211 SCHOOLHOUSE ST., COQUITLAM, BRITISH COLUMBIA
CANADA V3K 4X9 TELEPHONE (604) 520-3321
TELEX: ENVOY WPM 8076 TELECOPIER (604) 524-9186

REPORT OF A FLAME SPREAD TEST PROGRAM

CONDUCTED ON

SAFECOAT 451 FIRE RETARDANT COATING

CLIENT

MARATHON COATINGS TECHNOLOGY LTD.
4517 KLENIAK ROAD
BOX 5914, STATION L
EDMONTON, ALBERTA
T6C 4E5

REPORT PREPARED BY

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.
FIRE LABORATORIES DIVISION
211 SCHOOLHOUSE STREET
COQUITLAM, B.C.
V3K 4X9

REPORT NUMBER:	**5667**
JOB NUMBER:	**50493-C7-566700**
DATE TESTED:	**JANUARY 5, 9, 11 & 30, 1990**
TEST STANDARDS:	**CAN4 S102 M88**
	ASTM E84-89

VANCOUVER EDMONTON CALGARY TORONTO HAMILTON OTTAWA MONTREAL HALIFAX LONDON MADRID BRUSSELS BAHRAIN

PREFACE

This report describes the tests, standards and details for the sample of Safecoat 451 Fire Retardant Coating manufactured by Marathon Coatings Technology Ltd., applied on Douglas Fir 1" x 4" T & G Flooring Decks as described in the standards.

This report does not automatically imply product certification. Products must bear WHI labels in order to demonstrate Warnock Hersey certification.

TABLE OF CONTENTS

	PAGE
PRETEST INSPECTION	1
INTRODUCTION	2
MATERIAL SPECIFICATIONS	3
TEST PROCEDURES:	
FLAME SPREAD CLASSIFICATION	4
SMOKE DEVELOPED	5
FUEL CONTRIBUTED	5
TEST RESULTS	6
CONCLUSIONS	9
TIME/DISTANCE CURVES	11
TIME/TEMPERATURE CURVES	16
SMOKE DEVELOPED CURVES	21

Marathon Coatings Technology Ltd.
Report No. 5667

PRETEST INSPECTION

The pretest inspection was carried out on December 15, 1989 by Mr. R.A. Etherington, P. Eng., representing Warnock Hersey. The details of that inspection are on file at Warnock Hersey and will be used to form the basis for our follow up Factory Inspection Program.

INTRODUCTION

On January 5, 9, 11 & 30, 1990 the Fire Laboratories Division of Warnock Hersey conducted a test program to determine the surface burning characteristics of Safecoat 451 Fire Retardant Coating.

Testing was conducted in accordance with CAN4 S102 M88 and ASTM E84-89, "Standard Method of Test for Surface Burning Characteristics of Building Materials".

Upon receipt of the samples at the Warnock Hersey laboratory they were placed in the conditioning room where they remained in an atmosphere of 23 ± 3°C (73.4 ± 5°F) and 50 ± 5% relative humidity until they reach a constant weight.

Five trial runs were conducted.

Three trial runs were conducted in accordance with CAN 4 S102 M88 on the Coated 1" X 4" Douglas Fir T & G Flooring Deck.

One trial run was conducted in accordance with ASTM E84-89 on the Coated 1" X 4" Douglas Fir T & G Flooring Deck.

One trial run was conducted in accordance with CAN4-S102-M88 on an uncoated 1" X 4" Douglas Fir T & G Flooring Deck.

MATERIAL SPECIFICATIONS

The material tested was pretested by a Warnock Hersey inspector and submitted by the client.

The 1" X 4" Douglas Fir Tongue and Groove Flooring Decks were assembled and submitted by the client. The Safecoat 451 was applied at Warnock Hersey as per the clients' instructions.

Application Rate:	4.09 m^3/Litre (200 sq. ft./imp. gal.)
Method:	Spray or Brush Method used: commercial airless spray gun
Color:	White
Storage and Handling:	Do not allow to freeze 0° C (32° F). Water soluble, Latex.
Flash Point of Liquid Coating:	Closed Cup, 47°C

The publication of the flash point data in the listing is not intended to establish a relative flammability classification of the liquid coating, but to indicate the flasing characteristics of the liquid coatings under a standard test procedure. The flash point is 47°C.

TEST PROCEDURE

The results of the test are expressed by three indexes. Each index expresses the characteristics of the sample under test relative to that of select grade red oak flooring and asbestos-cement board.

(A) FLAME SPREAD CLASSIFICATION

This index relates to the rate of progression of a flame along a sample in the 25 foot tunnel.

A natural gas flame is applied to the front of the sample at the start of the test and drawn along the sample by a draft kept constant for the duration of the test.

An observer notes the progression of the flame front relative to time.

The flame spread classification for red oak flooring is 100, and 0 for asbestos-cement board.

CAN4 S102 M88 CALCULATIONS

According to the test standard, the flame spread classification is equal to $\frac{5363}{(195-A_t)}$ when A_t is the total area beneath the flame spread curve, if this area exceeds 97.5 minute-feet.

If the area beneath the curve is less than or equal to 97.5 minute-feet the classification becomes $.564 \times A_t$.

ASTM E84 CALCULATIONS

According to the test standard, the flame spread classification is equal to $\frac{4900}{(195-A_t)}$ when A_t is the total area beneath the flame spread curve, if this area exceeds 97.5 minute-feet.

If the area beneath the curve is less than or equal to 97.5 minute-feet the classification becomes $.515 \times A_t$.

TEST PROCEDURE: (continued)

(B) SMOKE DEVELOPED

A photocell is used to measure the amount of light which is blocked off by the smoke passing down the tunnel duct.

When the smoke from a burning sample blocks the light beam, the output from the photocell decreases. This decrease with time is recorded and compared to the results obtained for red oak which is 100.

CALCULATIONS

$$\frac{10{,}000 - (\text{smoke integrator reading}) \times 100}{630} = \text{smoke developed}$$

(C) FUEL CONTRIBUTED

This is a measure of how much heat energy is given off by the burning of the sample in addition to that which is supplied by the natural gas burners.

The air temperature at the vent end of the tunnel is monitored throughout the test and the results are plotted versus time and compared to the results for red oak.

CALCULATIONS

$$\frac{[1.5 \times (\text{temperature integrator reading})] - 4968 \times 100}{4195.5} = \text{fuel contributed}$$

TEST RESULTS

FLAME SPREAD

The resultant flame spread classifications, is as follows:
(rounded to nearest 5)

TRIAL	TEST METHOD	AREA UNDER CURVE	FLAME SPREAD CLASSIFICATION
1	S102	17	9
2	S102	20	11
3	S102	17	9
Average		18	10
4	E84	23	15
5	S102 uncoated	121	75

TEST RESULTS: (continued)

SMOKE DEVELOPED

The areas beneath the smoke developed curve and its related classification, is as follows: (rounded to nearest 5)

TRIAL	TEST METHOD	AREA UNDER CURVE	SMOKE DEVELOPED
1	S102	492	78
2	S102	350	55
3	S102	649	103
Average		497	80
4	E84	517	80
5	S102 uncoated	675	105

TEST RESULTS: (continued)

FUEL CONTRIBUTED

The resultant areas under the time/temperature curve and its related classification, is as follows: (rounded to nearest 5)

TRIAL	TEST METHOD	AREA UNDER CURVE	FUEL CONTRIBUTED
1	S102	3645	11
2	S102	3668	12
3	S102	3567	9
Average		3626	10
4	E84	3487	5
5	S102 uncoated	4745	50

CONCLUSIONS

The samples of Safecoat 451 coated and uncoated 1" X 4" Douglas Fir T & G Flooring Decks submitted by Marathon Coatings Technology Ltd. exhibited the following flame spread characteristics, when tested in accordance with CAN4 S102 M88 and ASTM E84-89.

	METHOD	FLAME SPREAD CLASSIFICATION	SMOKE DEVELOPED	FUEL ** CONTRIBUTED
Coated	S102	10	80	10
Coated	E84	15	80	5
Uncoated	S102	75	105	50

** This is an apparent value, not a real value.

The Safecoat 451 fire retardent coating material is classified as to the surface burning characteristics of the single coating system and the specific surfaces to which they are applied at the specific coverage indicated in the listing.

Safecoat 451 has met the eligibility requirements by reducing the flamespread of Douglas Fir by at least 50% or to a flamespread of 50 or less.

As indicated in the listings, the surface burning characteristics of the Safecoat 451 Fire Retardent Coating are only applicable when applied at the specified rate of coverage on the specific surface indicated, and is applied in accordance with the directions on the container. The wear and aging of the coating with respect to the performance characteristics have not been investigated, therefore the useful life is undetermined. Maintenance of the coating is of paramount importance for continued effectiveness.

The Douglas Fir substrates consist of 17mm x 89mm finished tongue and groove flooring. The flamespread ratings of uncoated Douglas Fir tongue and groove flooring range from 70 to 100.

CONCLUSIONS: (continued)

Authorities having jurisdiction should be consulted before application.

This product is therefore eligible for listing and labelling under the certification program of Warnock Hersey Professional Services Ltd.

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.

Tested by: _____
Fred Yasuda
Technician
Fire Laboratories Division

Reviewed by: _____
Marshall James
Supervisor
Fire Laboratories Division

FY/dlb

WP/90/02/23

TIME/DISTANCE CURVE

RUN NO. 1

FLAME SPREAD RESULTS FOR :

MARATHON COATING TECH. LTD.

PRODUCT: SAFECOAT 451 / D.FIR DECK 200 SQ FT / IMP GAL

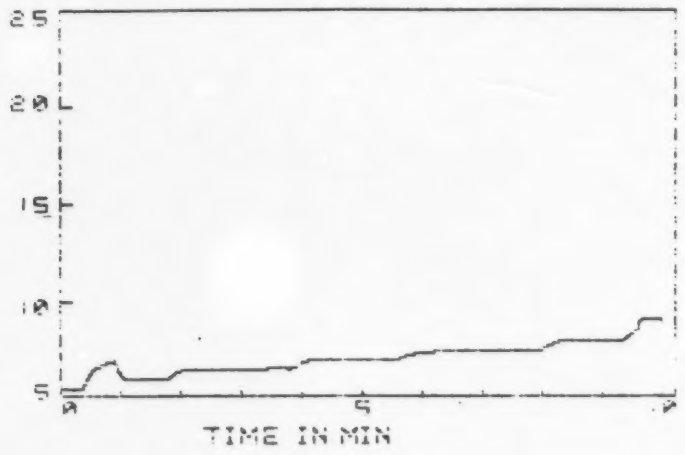
TEST DATE: 01/05/90

TEST STANDARD: CAN4 S102 M88

WORK ORDER: 50493-C7-566700

RUN NUMBER: 1

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******



********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE 17 FT-MIN

FLAME SPREAD CLASSIFICATION FSC1 9

SMOKE DEVELOPED 78

FUEL CONTRIBUTED 11

MAXIMUM DISTANCE REACHED 9.1 FT. AT 565.5 SEC.

TIME/DISTANCE CURVE

RUN NO. 2

FLAME SPREAD RESULTS FOR :

MARATHON COATING TECH. LTD.

PRODUCT: SAFECOAT 451 / D.FIR DECK 200 SQ FT / IMP GAL

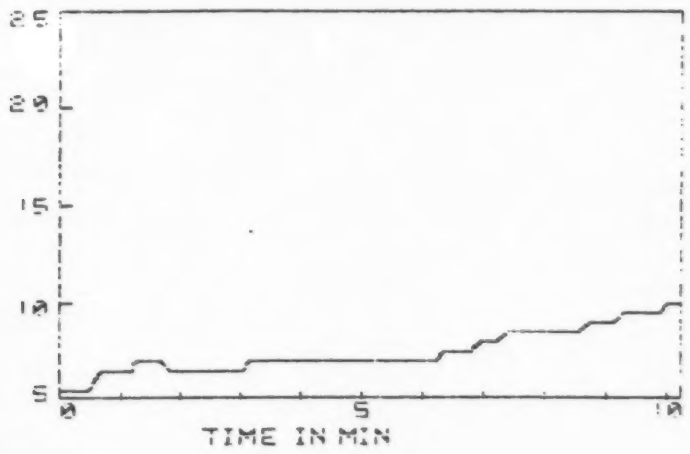
TEST DATE: 01/09/90

TEST STANDARD: CAN4 S102 M88

WORK ORDER: 50493-C7-566700

RUN NUMBER: 2

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******



********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE 20 FT-MIN

FLAME SPREAD CLASSIFICATION FSC1 11

SMOKE DEVELOPED 55

FUEL CONTRIBUTED 12

MAXIMUM DISTANCE REACHED 10 FT. AT 586 SEC.

TIME/DISTANCE CURVE

RUN NO. 3

FLAME SPREAD RESULTS FOR :

MARATHON COATING TECH. LTD.

PRODUCT: SAFECOAT 451 / D.FIR DECK 200 SQ FT / IMP GAL

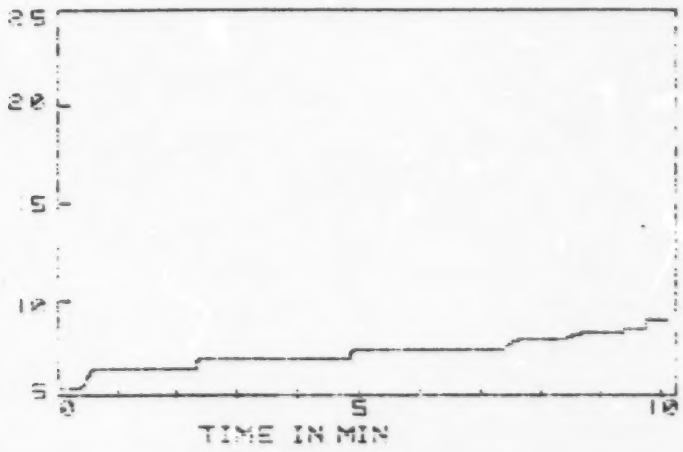
TEST DATE: 01/09/90

TEST STANDARD: CAN4 S102 M88

WORK ORDER: 50493-C7-566700

RUN NUMBER: 3

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******



********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE 17 FT-MIN

FLAME SPREAD CLASSIFICATION FSC1 9

SMOKE DEVELOPED 103

FUEL CONTRIBUTED 9

MAXIMUM DISTANCE REACHED 8.9 FT. AT 571.5 SEC.

TIME/DISTANCE CURVE

RUN NO. 4

FLAME SPREAD RESULTS FOR :

MARATHON COATING TECH. LTD.

PRODUCT: SAFECOAT 451 / D.FIR DECK 200 SQ FT / IMP GAL

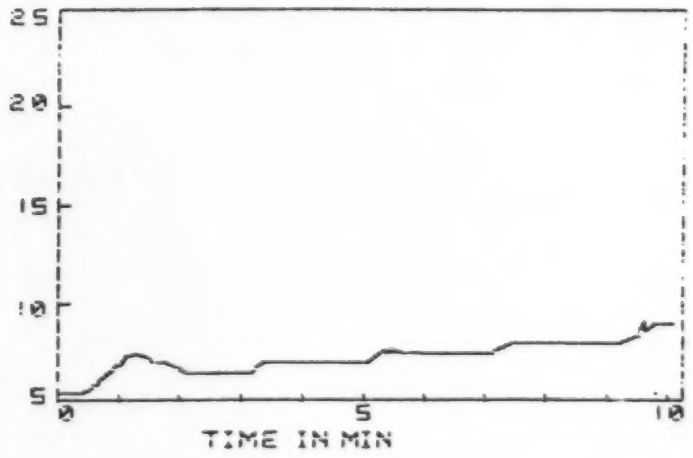
TEST DATE: 01/11/90

TEST STANDARD: ASTM E84-84

WORK ORDER: 50493-C7-566700

RUN NUMBER: 4

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******



********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE 23 FT-MIN

FLAME SPREAD CLASSIFICATION FSC1 13

SMOKE DEVELOPED 82

FUEL CONTRIBUTED 6

MAXIMUM DISTANCE REACHED 9.1 FT. AT 563.5 SEC.

TIME/DISTANCE CURVE

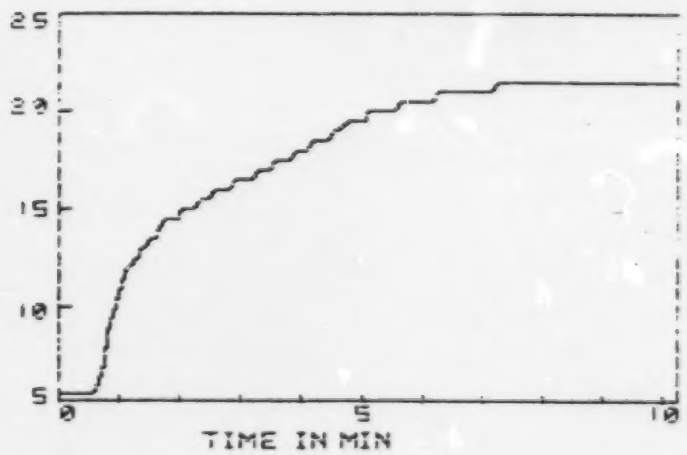
RUN NO. 5

FLAME SPREAD RESULTS FOR :

MARATHON COATING TECH. LTD.

PRODUCT:	1"X4" DOUGLAS FIR DECK
TEST DATE:	01/30/90
TEST STANDARD:	CAN4 S102 M88
WORK ORDER:	50493-C7-566700
RUN NUMBER:	5

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******



********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE	121 FT-MIN
FLAME SPREAD CLASSIFICATION FSC	1 73
SMOKE DEVELOPED	107
FUEL CONTRIBUTED	51

MAXIMUM DISTANCE REACHED 21.5 FT. AT 423 SEC.

********** WARNOCK HERSEY **********

FLAME SPREAD RESULTS FOR :

MARATHON COATINGS TECH LTD.

PRODUCT: SAFECOAT 451 / .5" PLYWOOD 200 SQ FT/IMP GAL

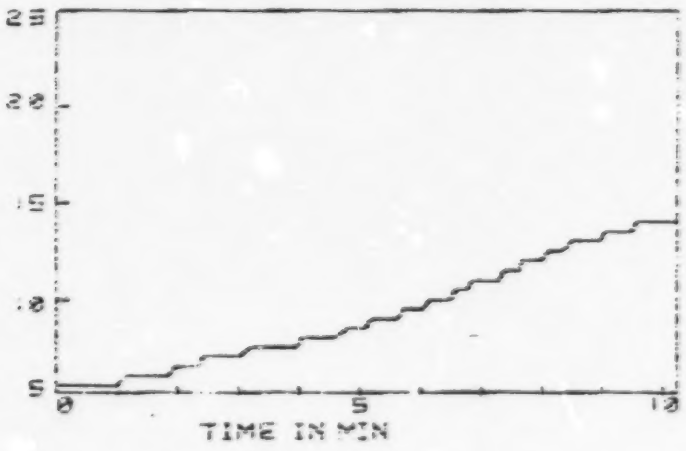
TEST DATE: 02/13/90

TEST STANDARD: CAN4 S102 M88

WORK ORDER: 50493-C7-566700

RUN NUMBER: 6

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******



********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE 37 FT-MIN

FLAME SPREAD CLASSIFICATION FSC1 20

SMOKE DEVELOPED 124

FUEL CONTRIBUTED 24

MAXIMUM DISTANCE REACHED 14 FT. AT 559 SEC.

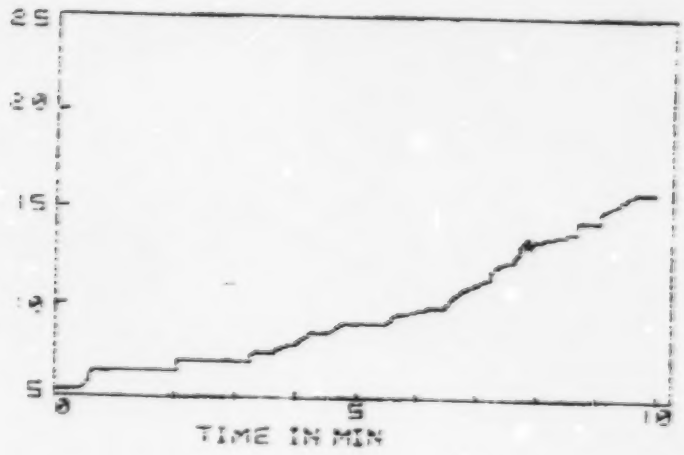
********** WARNOCK HERSEY **********

FLAME SPREAD RESULTS FOR :

MARATHON COATINGS TECH. LTD.

PRODUCT: SAFECOAT 451 / .5" OSB 180 SQ FT / IMP GAL
TEST DATE: 02/13/90
TEST STANDARD: CAN4 S102 M88
WORK ORDER: 50493-C7-566700
RUN NUMBER: 7

******* FLAME TRAVEL IN FEET vs TIME IN MINUTES *******

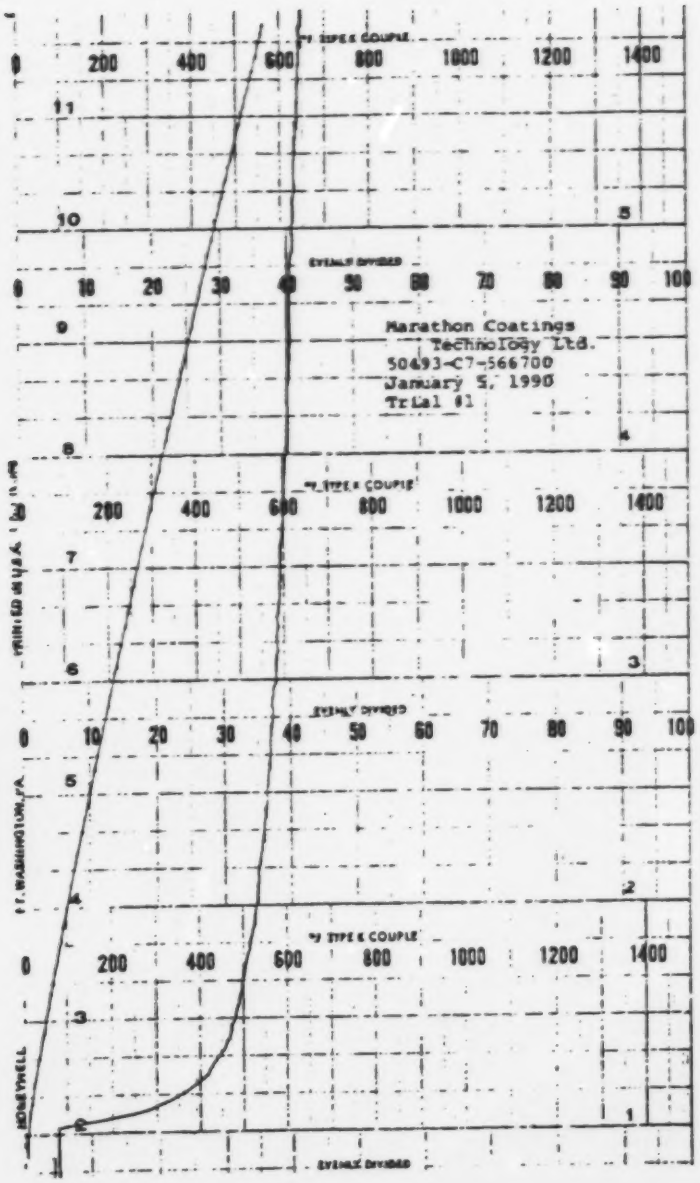


********** TEST RESULTS **********

AREA UNDER TIME DISTANCE CURVE 43 FT-MIN
FLAME SPREAD CLASSIFICATION FSC: 24
SMOKE DEVELOPED 137
FUEL CONTRIBUTED 27
MAXIMUM DISTANCE REACHED 15.8 FT. AT 562.5 SEC.

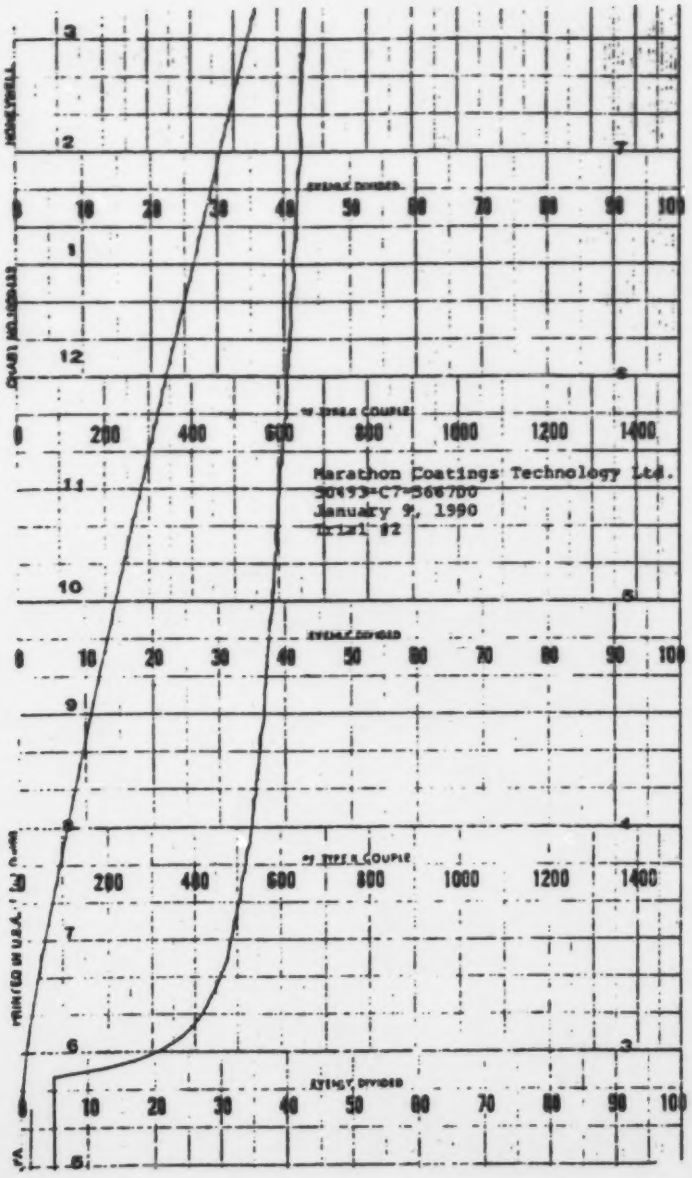
TIME/TEMPERATURE CURVE

TRIAL NO. 1



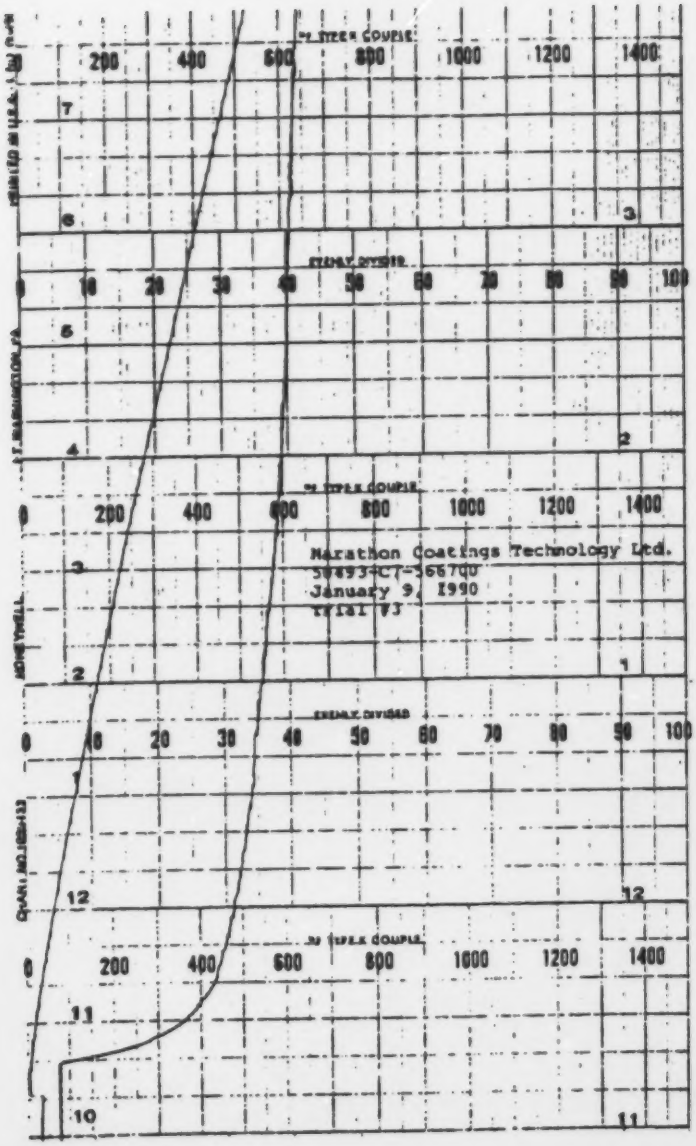
TIME/TEMPERATURE CURVE

TRIAL NO. 2



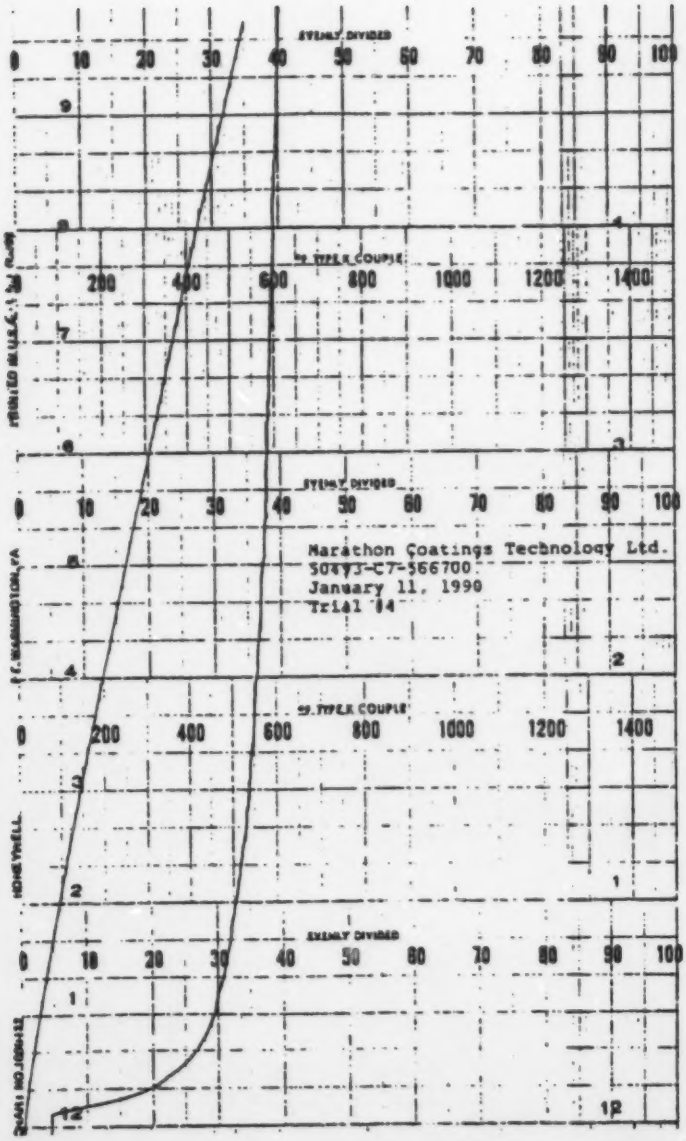
TIME/TEMPERATURE CURVE

TRIAL NO. 3



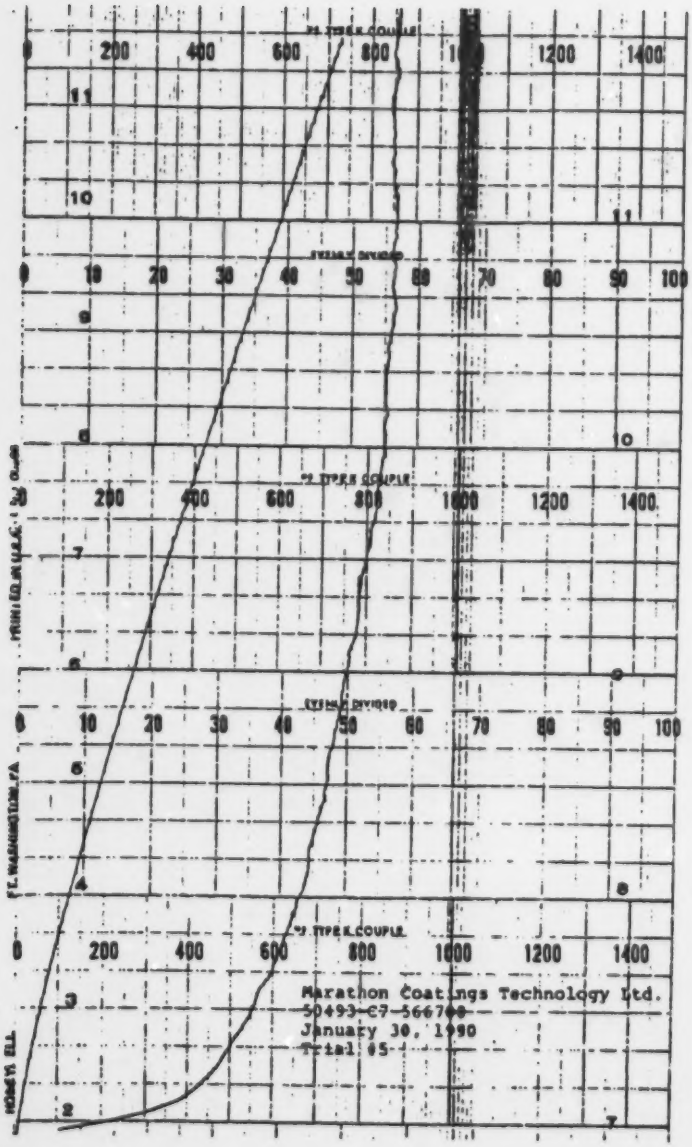
TIME/TEMPERATURE CURVE

TRIAL NO. 4



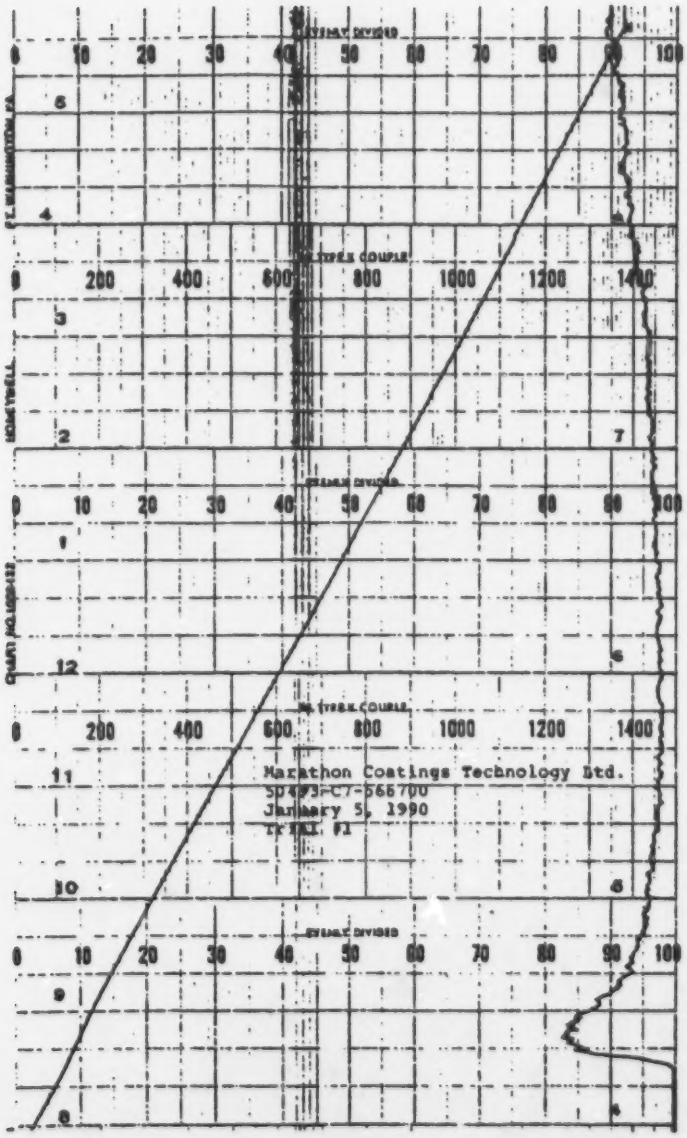
TIME/TEMPERATURE CURVE

TRIAL NO. 5



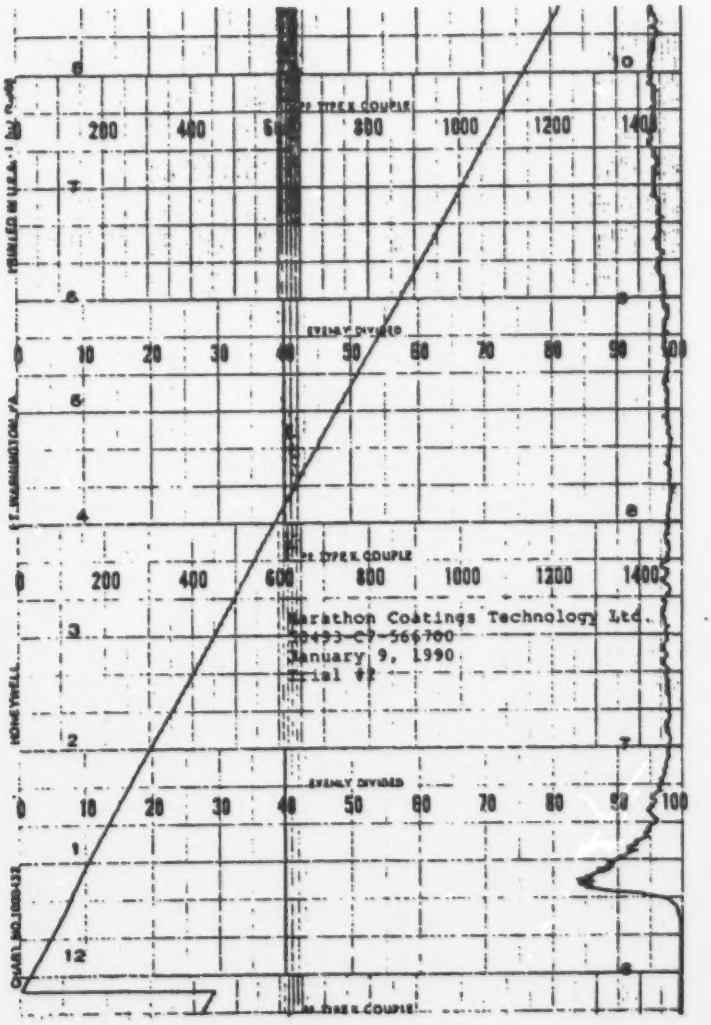
SMOKE DEVELOPED CURVE

TRIAL NO. 1



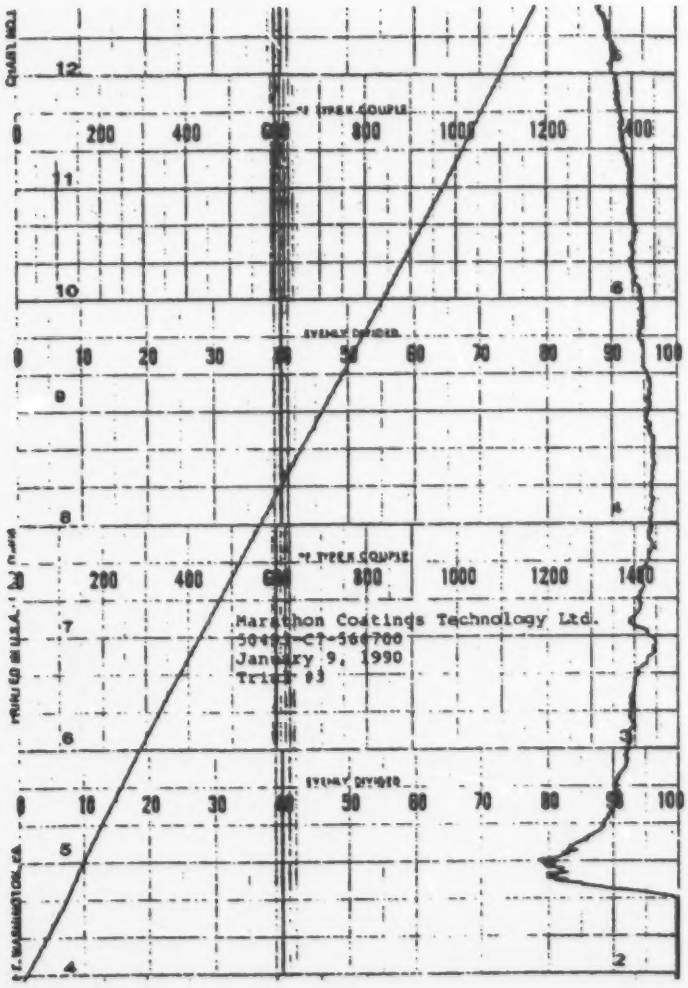
SMOKE DEVELOPED CURVE

TRIAL NO. 2



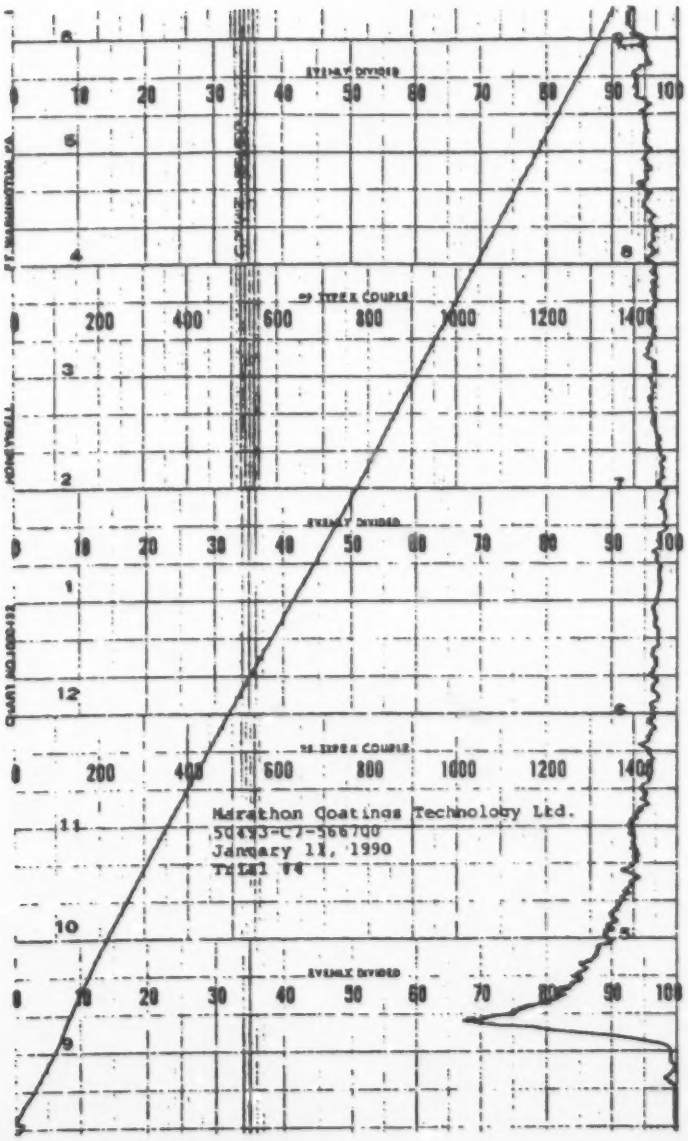
SMOKE DEVELOPED CURVE

TRIAL NO. 3



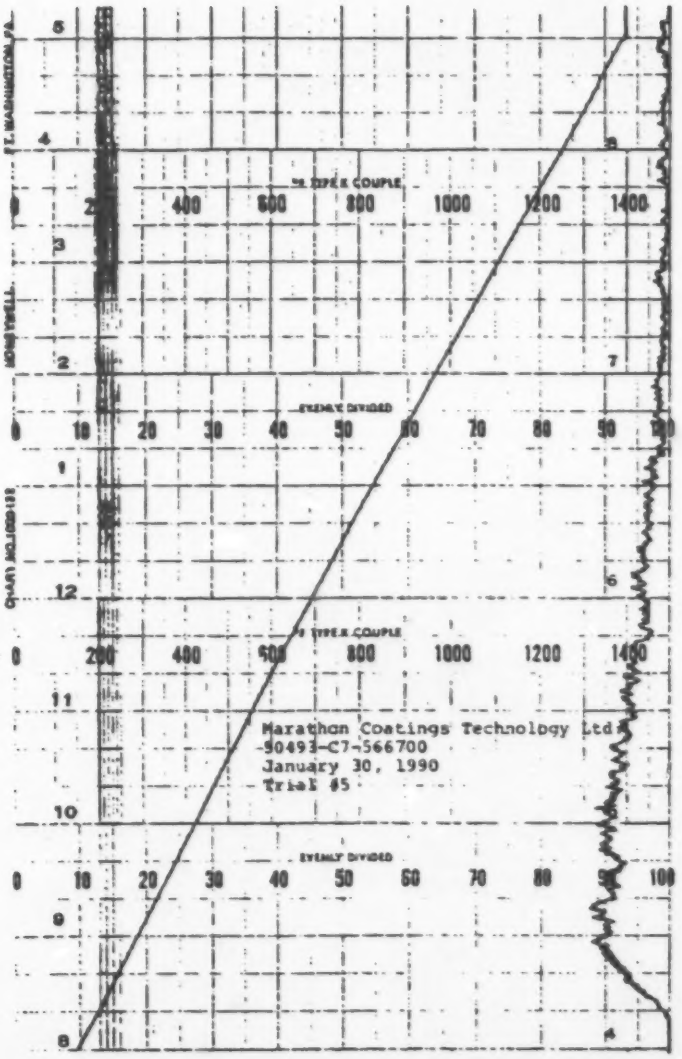
SMOKE DEVELOPED CURVE

TRIAL NO. 4



SMOKE DEVELOPED CURVE

TRIAL NO. 5



APPENDIX C: Alberta Labour Standata

Alberta
LABOUR
General Safety Services Division
Building Standards Branch

705, 10808 - 99 Avenue, Edmonton, Alberta, Canada T5K 0G5 403/427-8285 Fax 403/422-3542

1990 03 22

Mr. M. Mabey
Marathon Coatings Technology Ltd.
Capitol Industrial Park
Box 5914, Station L, Edmonton T6C 4G5

Attn: Mr. Mabey:

Re: Product Listing 85-PL-190 for Safecoat Formula 451

The attached product listing bulletin constitutes acceptance of the use of the product in buildings in Alberta. Copies of the bulletin will be sent by us in the near future to building officials throughout Alberta.

If you wish to distribute copies of the bulletin to designers, contractors, and other potential costumers, you may make direct copies. No other material may be added to the bulletin and the bulletin shall not be changed by deletion or rewording.

The bulletin is the property of the Building Standards Branch and is to be treated as technical information provided by the Branch for the purpose of informing the construction industry in Alberta about new products that can be used and the conditions of their acceptance. The bulletin is not to be used as or included with other advertising material.

The bulletin will be reviewed on or before the review date and may be withdrawn at any time if subsequent information is received that the product no longer satisfies the intent of the Alberta Building Code.

Changes in materials, specification or application that affect the product and its acceptance should be sent to the Building Standards Branch for review.

Sincerely,

Bruce H. Allen

Bruce H. Allen MRAIC
Research and Approvals Officer
BA/ba

PRODUCT LISTING

STANDATA

NO. 85-PL-190

CATEGORY: INTERIOR FINISH (Fire Retardant)

ISSUE DATE: 1990 03 15 REVIEW DATE: 1992 03 15

MANUFACTURER:
MARATHON Coatings Technology Ltd.
Capital Industrial Park
Box 5914, Station L, Edmonton T6C 4G5

REPRESENTATIVE IN ALBERTA:
MARATHON Coatings Technology Ltd.
Capital Industrial Park
Box 5914, Station L, Edmonton T6C 4G5

PRODUCT: SAFECOAT FORMULA 451

DESCRIPTION

SAFECOAT Formula 451 is a high solids, latex-based "intumescent" fire-retardant surface coating intended for application on wood building materials.

USE AND LIMITATIONS

SAFECOAT Formula 451 has been tested for use on Oriented Strand Board OSB, SPF plywood, and dimensional lumber (Douglas Fir decking minimum 25 mm thick).

The product may be used to impart a flame spread rating of less than 25 when applied in a single coat application at the rate of:

4.087 m^2 per litre on Douglas Fir decking

(200 $ft.^2$ per imp. gal.)

4.087 m^2 per litre on SPF plywood

(200 $ft.^2$ per imp. gal.)

3.68 m^2 per litre on Oriented Strand Board (OSB)

(180 $ft.^2$ per imp. gal.)

ISSUE OF THIS LISTING IS AUTHORIZED UNDER SENTENCE 1.5.4.2(9) OF THE ALBERTA BUILDING CODE 1985 BY THE DIRECTOR OF BUILDING STANDARDS D. O. MONSEN, M.R.A.I.C.

Alberta

Application is single coat using high pressure, airless spray gun equipment.

The addition of a finish coat such as latex paint, alkyd paint, urethane coatings, etc. will effect the expected flame-spread ratings and smoke developed classification.

SAFECOAT Formula 451 may be tinted with a latex based "Universal Tint" provided that the addition rate does not exceed 26 ml per litre of the product.

SAFECOAT Formula 451 is for interior applications. It has not been tested for weathering.

The product may be partially removed by constant scrubbing or washing with strong alkaline solutions and should not be applied to surfaces which will receive this treatment.

CODE REQUIREMENTS

In both combustible and noncombustible construction, required flame-spread ratings depend upon specific location in a room space or building and upon the use and occupancy of the space.

In noncombustible construction the use of combustible finishes are regulated by Clause 3.1.4.5.(3)(f),(g), and (h).

Subsection 9.10.16. "Flame Spread Limits", Subsection 3.1.10. "Flame-Spread Rating and Smoke Developed Classification" and Subsection 3.1.11. "Interior Finishes" specify the flame-spread requirements for buildings regulated by the Alberta Building Code 1985.

TECHNICAL DATA

Testing was conducted in accordance with CAN4-S102-M83 "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies" by Warnock Hersey in

January of 1990. Following is a summary of the results of those tests.

MATERIAL	*F.S.R.	*S.D.C.	*F.C.
Douglas Fir Lumber 25 mm nominal thickness coated with SAFECOAT Formula 451 in a single coat at a rate of 4.087 m² per litre.	11	55	12
Oriented Strand Board 25 mm nom. thickness coated with SAFECOAT Formula 451 in a single coat at a rate of 3.68 m² per litre.	24	137	27
SPF Plywood, 25 mm nom. thickness, coated with SAFECOAT Formula 451 in a single coat at a rate of 4.087 m² per litre.	20	124	24

*F.S.R. - flame-spread rating

*S.D.C. - smoke developed classification

*F.C. - fuel contributed

!!Note: The flammability characteristics of different species of lumber vary, however, the practice of using Douglas Fir as a standard test substrate provides a basis for the comparison of various coatings.

It is accepted that the above mentioned values for Douglas Fir can be attributed to other species of lumber predicted to have a flame spread of 100 or less providing the lumber is minimum nom. 25 mm thick. These other species include:

Eastern white pine
Lodgepole pine
Pacific Coast Yellow Cedar
Select Red Oak Flooring

Western Hemlock
Western Red Cedar
Western White Pine
White Spruce

APPLICATION

The surface to be treated must be dry, clean and free from dirt and grease.

Surface and air temperature must be maintained above 4.5 °C during application.

If the surface to receive the coating has been previously painted, apply a single coat of the chemically compatible SAFECOAT Acrylate Primer at a rate of 8.17 m^2 per litre (400 $ft.^2$ per imp. gal.) allowed to dry for at least 4 hr. before applying SAFECOAT Formula 451, as specified. The completed application must be allowed to dry for at least three days before being subjected to washing or other moisture.

IDENTIFICATION AND CERTIFICATION

Each container bears a label reading "Warnock Hersey Laboratories of Canada - Listed - Fire Retardant Coating".